

Desertification in Europe

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1. Abstract

A common misunderstanding is that desertification is linked to the presence of deserts. The truth is that desertification can and does occur far from any climatic desert, as the presence or absence of a nearby desert has no direct relation to desertification. Desertification is the result of human induced land degradation which can be accelerated under severe drought conditions, and can occur under very diverse climatic conditions. This is particularly the case for Europe, with extensive desertification processes occurring both in the Mediterranean and in the Central and Eastern European countries. Both areas have been recognized within the UNCCD as affected and are grouped within the convention under annex IV (Mediterranean) and annex V (Central and Eastern Europe) of UNCCD. Main desertification processes occurring in these areas are related to soil erosion, loss of soil organic carbon, contamination, salinisation, soil compaction, soil sealing, loss of soil biodiversity and landslides. These threats have been included in the recently adopted Soil Thematic Strategy of the European Commission and will require urgent action in the near future in order to reverse the negative trends. A full assessment of the major degradation processes and their driving forces, pressures, impacts and possible responses still is lacking. Preliminary results already allow for an extensive mapping of major risk areas for the various threats and would form a good basis for National and local action plans, as required by the UNCCD and the Soil Thematic Strategy.

2. Introduction

The adoption of the EU Thematic Strategy for Soil Protection by the European Commission (the Strategy; EC 2006a) has given formal recognition of the severity of the soil and land degradation processes within the European Union and its bordering countries. The thematic strategy underlines that soil degradation processes or threats or a combination of some of the threats can ultimately lead to desertification. The Strategy includes an extended impact assessment (EC 2006b) that has quantified soil degradation in Europe, both in environmental and economic terms, and that is the basis for this report.

Available information suggests that, over recent decades, there has been a significant increase in soil degradation processes, and there is evidence that these processes will further increase if no action is taken. Soil degradation processes are driven or exacerbated by human activity. Climate change, together with individual extreme weather events, which are becoming more frequent, will also have negative effects on soil.

Soil degradation processes occurring in the European Union include erosion, organic matter decline, compaction, salinisation, landslides, contamination, sealing and biodiversity decline.

3. Degradation processes leading to desertification in Europe

3.1 Erosion

Erosion is a natural process, which can however be significantly accelerated by human activities. It is known to be a serious problem throughout Europe, especially in the Mediterranean zone, but snowmelt erosion happens in Scandinavian countries and wind erosion is common in Central and Western Europe. Main human-induced driving forces include soil disturbance, removal of vegetative soil cover and/or hedgerows, increased field size (open fields), abandonment of terraces, late sowing of winter cereals, overstocking, inappropriate use of heavy machinery, in agricultural and forestry practices, but also during construction works.

The European Environmental Agency (EEA, 1995) estimated 115 million ha, or 12% of Europe's total land area, to be affected by water erosion, and that 42 million ha are affected by wind erosion, of which 2% severely affected. Due to the difficulty to assess the affected area, erosion risk has been proposed as an indicator of actual

erosion, which can be assessed on the basis of predictive models such as PESERA (Kirby et al. 2004). This model covers most of the European Union, except Sweden, Finland, Malta and Cyprus, where Corinne Land cover data was not available. PESERA predicts that overall 3.4% of the area (1.6 million ha) is at risk from erosion of more than 10 tonnes (t) ha⁻¹ yr⁻¹, 18% (54 million ha) are at risk of losing soil above 1 t ha⁻¹, and 25% of the area (corresponding to 75.5 million ha) is at risk to lose more than 0.5 t of soil ha⁻¹ yr⁻¹. The Mediterranean region is the most affected, but there is clear evidence that also other parts of the EU suffer significant soil erosion.

The consequences of erosion for soil functions and soil ecosystems are significant. Loss of soil, loss of fertility, excessive sediment load, reduced water retention capacity, hence higher flood risk can all lead to desertification.

3.2 Decline of soil organic matter (SOM)

SOM, the organic fraction of soil (not including undecayed plant and animal residues) often called as humus plays an important role in the functioning of soil. Humus possesses colloidal characteristics which give it the ability to improve soil properties such as structure and porosity, sorption capacity (water, plant nutrients), protection against erosion, buffering capacity and protection of plants from drastic changes in pH, and store for microorganisms.

SOM plays a major role in the carbon cycle of the soil. Indeed, soil is at the same time an emitter of greenhouse gases and also a major store of carbon, therefore SOM influencing desertification through direct (soil internal processes) and indirect (climate change) ways. As a part of the European Climate Change Programme (ECCP), the potential of soils for carbon sequestration was estimated to be equivalent to 1.5-1.7% of the EU's anthropogenic CO₂ emissions during the first commitment period of the Kyoto protocol.

Comprehensive and comparable data for Europe on SOM content are not available, but models exist to estimate it. According to Jones et al. (2005) around 45% of soils in Europe have a low or very low organic matter content (0-2% organic carbon) and 45% have a medium content (2-6% organic carbon).

The development of a Common Implementation Strategy (CIS) has been discussed with Member States and was generally welcomed. In such a CIS, guidance documents would be produced inter alia based on already existing documents to facilitate risk identification. With the forming of the soil carbon management strategy of the European Commission (Stolbovoy et al. 2007) detailed figures of SOM dynamics of European soils may be available in the coming years, to base further action plan on.

3.3 Compaction

Compaction, the degradation of soil structure by an increase in bulk density, decreases soil porosity, thus causing negative effect on soil water regime. Compaction is a problem mainly of the subsoil. Main human induced driving forces of compaction include inappropriate use of heavy machinery and increased use of high axle loads, high livestock densities, in particular in wet conditions or on wet soils, large constructions works.

Estimates of areas at risk of soil compaction vary. While they all demonstrate the importance of soil compaction, enough data were not available on the actual occurrence of compaction, but data were available on the susceptibility of soils to compaction. Some authors (Van-Camp et al. 2004a) classify around 36% of European subsoils as having high or very high susceptibility to compaction. Other sources (Crescimanno et al. 2004) speak of 32% of soils being highly vulnerable and 18% moderately affected, while some other sources (Van Ouwerkerk and Soane 1995) estimate 33 million ha being affected in total, meaning 4% of the European land.

Compaction has consequences in changed soil structure, reduced water infiltration and retention resulting in increased water run-off, higher erosion susceptibility, increased emission of greenhouse gases from the soil due to changes in nutrient cycle. These changes can accelerate desertification processes.

3.4 Salinisation

Salinisation, the accumulation in soils of soluble salts mainly of sodium, magnesium, and calcium, can occur naturally in low, poorly drained areas in hot and dry climates, where surface water collects and evaporates, but can be exacerbated by human activities, in particular due to inadequate irrigation of agricultural land. Main human-induced driving forces for salinisation include poor irrigation technology, inappropriate drainage, use of saline waters for irrigation and the overexploitation of groundwater.

Salinisation affects around 3.8 million ha in Europe (EEA 1995). Most affected are Campania in Italy, the Ebro Valley in Spain, and the Great Alföld in Hungary, but also areas in Greece, Portugal, France, Slovakia and Austria (Katakouzinis 1968).

The consequences of salinisation that can induce desertification include, loss of soil fertility due to toxic effects of high salt content, reduced water infiltration and retention resulting in increased wa-ter run-off, damage to water supply infrastructure.

3.5 Landslides

Landslides are natural phenomena, which can be exacerbated by human activity or, on the contrary, by lack of human activity. Landslides often occur more frequently in areas with highly erodible soils, clayey subsoil, steep slopes, intense and abundant precipitation and land abandonment such as the Alpine and the Mediterranean regions. Main human induced driving forces for landslides include rupture of topography, extractions of materials and land use changes such as deforestation and land abandonment.

There are no sufficient data on the total affected area in the EU. In Italy, more than 50% of the territory has been classified as having a high or very high hydro-geological risk, affecting 60% of the population, i.e. 34 million inhabitants. More than 15% of the territory and 26% of the population are subjected to a very high risk (EEA 2000, MOE 2000) and eight major landslides have been documented by the International Disaster Data-base. The threat of landslides is increasing due to population growth, summer and winter tourism, intensive land use and climate change.

Consequences of landslides are mainly linked to risk to humans and economy (loss of human lives and well-being; damage to property and infrastructure; indirect negative effects on economic activities due to interruption of transport routes; potential contamination of surface waters) but it may hinder soil functioning by deteriorating fertility, loss of topsoil or by contamination of soil due to damage to infrastructure.

3.6 Contamination

Soil contamination is a widely spread problem across all Europe. Most experts acknowledge that the data available are insufficient for assessing certain parameters, such as the total surface area contaminated per class of contaminant, the percentage of population exposed to the contamination, the environmental damage caused by contaminated sites, etc. This is partly because the data collected by each Member State are not comparable.

Available information indicates that the extent of contaminated sites across Europe is enormous and there is a very unequal progress among Member States in addressing the issue, some being very advanced in the identification of the extent and localisation of the problem, some others only at very preliminary phases.

The effects of soil contamination are very diverse and far reaching in their consequences. Once contaminated, soil functions may be impaired and human and ecological health and food quality may also be prejudiced. The consequences can be suffered where the contamination occurs but are mostly suffered also in a large surrounding area, including agricultural land, dwellings and/or nature reserves (EEA 1995).

Consequences of soil contamination have their effect on the process of desertification through:

- The indirect consequences of contamination of surface water, mainly through run off of contaminated sediments
- Risk of ecotoxicity for the flora and fauna living in the soil on the site and around a contaminated site causing loss of biodiversity and biological activity
- Loss of soil fertility due to disrupted nutrient cycles
- Restrictions on land use and hindering future redevelopment and reducing the area of productive and valuable soil available for other activities (agricultural and forestry production, recreation etc.)

3.7 Sealing

On average the sealed area, the area of the soil surface covered with an impermeable material, is around 9% of the total area in Member States (EEA 1999). In many European countries the built-up area increased by 25 to 75% in the period 1950-1980. During 1990-2000 the sealed area in EU15 increased by 6% (EEA 2006), and the demand for both new construction due to increased urban sprawl and better transport infrastructures continues to rise.

Soil sealing through urbanisation dominates in the more densely populated regions and major industrial areas of Western Europe, in particular Belgium, Denmark and the Netherlands, where 16-20% of the surface is built up. Sealing results in the creation of a horizontal barrier between the soil, air and the water and thus has several severe consequences.

Consequences of sealing that accelerates desertification include: disruption of water fluxes; increased flood risks; reduced groundwater recharge; increases water pollution loss in soil and terrestrial biodiversity (due to fragmentation of habitats)

3.8 Biodiversity

Soil biodiversity means not only the diversity of genes, species, ecosystems and functions, but also the metabolic capacity of the ecosystem (Van-Camp et al. 2004b).

Insufficient data exist on the status of soil biodiversity in Europe, as the biological quality of soil cannot easily be predicted. Although research on soil biodiversity has been carried out in European countries, it is still impossible to reliably quantify the richness, range and different roles played by microbial species.

Soil biodiversity is affected by all the threats listed above, and therefore all driving forces mentioned apply (equally) to the loss of soil biodiversity, changes in land use (agricultural and forestry practices) and soil contamination being the most prominent.

Biodiversity decline has consequences to the process of desertification through: reduced food web functioning and consequently crop yield losses; reduced soil formation; reduced nutrient cycling and nitrogen fixation, reduced carbon sequestration, reduced resilience of the soil to endure pressures, reduced recycling of organic waste/litter, increased plant pests and diseases, reduced water infiltration rate and water holding capacity, reduced bioremediation capacity, hampered soil structure (by affecting the stabilisation of organo-mineral complexes), negative impacts on terrestrial biodiversity outside of soil

4. Conclusions

Desertification is the result of the loss of soil functioning ability by land degradation processes. Land degradation in Europe is difficult to quantify due to the lack of up-dated and comparable data. Nevertheless, on the basis of the available data, extensive land degradation processes can be identified in Europe. These processes are mostly human induced and can be further exacerbated by the influence of extreme climatic events.

The Soil Thematic Strategy of the European Union paves the way towards adequate measures in order to reverse the negative trends in soil and land degradation in Europe. The implementation of the Strategy will have also an extensive impact on the efforts of desertification control on the Continent.

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